WHAT IS CLAIMED IS:

1. A method for designing a coil, comprising:

selecting a geometry for the coil;

selecting a region of interest for a magnetic field produced by the coil;

defining a stream function for the current density distribution of the coil, wherein the stream function is a sum of sinusoidal functions, wherein each sinusoidal function comprises an amplitude; and

numerically optimizing the amplitudes of the sinusoidal functions to produce a magnetic field of selected characteristics in the region of interest.

2. The method of claim 1, wherein the stream function is defined as follows:

$$S(x,y) = \sum_i A_i \sin(\frac{i\pi x}{a}).\sum_j B_j \sin(\frac{j\pi y}{b})/(i.j)$$

where A_i and B_j are Fourier coefficients representing the amplitudes of the sinusoidal functions in the x and y directions, respectively, and a and b are dimensions of the coil in the x and y directions, respectively.

3. The method of claim 1, wherein numerically optimizing the amplitudes of the sinusoidal functions comprises:

selecting an amplitude for each of the sinusoidal functions;

generating a plurality of current loops from the stream function for the selected geometry;

dividing the current loops into a plurality of elements;

calculating the magnetic field produced by the plurality of elements at a plurality of points in the region of interest; and

evaluating an error function based on the magnetic field at the plurality of points.

4. The method of claim 1, wherein numerically optimizing the current density comprises simulated annealing.

5. The method of claim 1, wherein the selected geometry for the coil comprises an open geometry.

6. The method of claim 1, wherein the selected geometry for the coil comprises a substantially half cylindrical shell.

7. The method of claim 1, wherein the coil comprises a gradient coil, wherein the selected characteristics comprise homogeneity of a gradient in a longitudinal direction relative to a main magnetic field.

8. The method of claim 1, wherein the coil comprises a gradient coil, wherein the selected characteristics comprise homogeneity of a gradient in a transverse direction relative to a main magnetic field.

9. The method of claim 1, further comprising modeling the selected geometry for the coil a three-dimensional modeling program.

10. The method of claim 1, wherein the amplitudes of the sinusoidal functions are controlled to produce a symmetric coil.

11. The method of claim 1, wherein the amplitudes of the sinusoidal functions are controlled to produce an asymmetric coil.

12. A coil designed using the method of claim 1.

13. A coil designed using the method of claim 1, wherein the coil is configurable for use in magnetic resonance imaging.

14. A coil designed using the method of claim 1, wherein the coil is configurable for use in transcranial magnetic stimulation.

15. A method of designing a coil comprising:

selecting an open geometry for the coil;

selecting a region of interest for a field produced by the coil;

defining a current density distribution for the coil; and

numerically optimizing the current density distribution to produce a field of selected characteristics in the region of interest.

16. The method of claim 15, wherein the selected geometry comprises a substantially half cylindrical shell.

17. The method of claim 15, wherein numerically optimizing the current density comprises simulated annealing.

18. The method of claim 15, wherein the coil comprises a gradient coil, wherein the selected characteristics comprise homogeneity of a gradient in a longitudinal direction relative to a main magnetic field.

19. The method of claim 15, wherein the coil comprises a gradient coil, wherein the selected characteristics comprise homogeneity of a gradient in a transverse direction relative to a main magnetic field.

20. The method of claim 15, further comprising modeling the selected geometry for the coil a three-dimensional modeling program.

21. The method of claim 15, wherein an amplitude of one or more coefficients of a stream function are controlled to produce a symmetric coil.

22. The method of claim 15, wherein an amplitude of one or more coefficients of a stream function are controlled to produce an asymmetric coil.

23. A coil designed using the method of claim 15.

24. A coil designed using the method of claim 15, wherein the coil is configurable for use in magnetic resonance imaging.

25. A coil designed using the method of claim 15, wherein the coil is configurable for use in transcranial magnetic stimulation.

26. An MRI system for imaging a brain comprising an open coil configurable to receive a head of a patient.

27. The MRI system of claim 26, wherein the open coil comprises a geometry adapted to substantially conform to a surface of a head.

28. The MRI system of claim 26, further comprising a stimulus device configurable to stimulate the brain.

29. The MRI system of claim 26, further comprising a stimulus device configurable to stimulate the brain for a brain activation study.

30. A method of imaging a brain, comprising:

positioning a head of a patient in an open coil of an MRI system; and

producing one or more images of the brain of the patient using the open coil.

31. The method of claim 30, further comprising stimulating the brain using a stimulus device.

32. The method of claim 30, further comprising:

stimulating the brain using a stimulus device; and

conducting a brain activation study using the one or more produced images of the brain.

33. A coil system comprising at least one open coil, wherein the open coil comprises a geometry adapted to substantially conform to a surface of a head.

34. The coil system of claim 33, wherein the at least one open coil comprises a substantially spherical shell.

35. An MRI system for imaging a subject, comprising:

a main magnet comprising a vertical bore; and

an open coil set, wherein the open coil set is disposed in the vertical bore such that an open portion of the open coil set faces upwardly in the vertical bore.

36. The MRI system of claim 35, wherein the open coil set comprises an open gradient coil.

37. The MRI system of claim 35, wherein the open coil set comprises a cradle.

38. The MRI system of claim 35, further comprising a stimulus device configurable to stimulate the brain.

39. The MRI system of claim 35, further comprising a support surface coupled to the open coil set, wherein the support surface is configurable to support a body of a laboratory animal horizontally.

40. A method of imaging a subject using an MRI system, comprising:

providing a main magnet comprising a vertical bore;

providing an open coil set in the vertical bore;

providing a support surface, wherein the support surface is coupled on a top surface of the open coil set;

positioning the subject on the support surface; and

producing an image of the subject.

41. The method of claim 40, wherein the subject comprises a laboratory animal, wherein the laboratory animal comprises a body, wherein the support surface is configurable to support the body of the laboratory animal horizontally.

42. A coil system comprising at least one open coil, wherein the at least one open coil is coupled with a support surface, wherein the support surface is configured to support a subject horizontally.

43. The coil system of claim 42, wherein the coil system is configured to mount in a vertical bore of an MRI system such that an open portion of the at least one coil having open geometry faces upwardly in the vertical bore.

44. The coil system of claim 42, wherein the open coil comprises an open gradient coil.